some whitish membrane; the colour of these organs is dark brown, faintly tinged with red.

Females of this species, in a state of complete development, have been found on several occasions among herbage growing in meadows and old pastures near Hendre House; and in May 1860, the Rev. O. P. Cambridge took adult individuals of both sexes on the banks of the Conway.

Tribe **Senoculina.**

Family Dysderidæ.

Genus Dysdera, Latr.

Dysdera obscura.

The male is smaller and much paler than the female, with the exception of the anterior legs, which have a browner hue; and near the middle of the metatarsus of each, towards the outer side, there is a strong, obtuse, prominent process terminated by a short, fine spine. Its palpi are short, and of a yellowish-white hue; the radial is much larger than the cubital joint and has the appearance of being swollen; the digital joint is small, oval, convex and hairy externally; and the palpal organs, which are subglobular at the base, but prolonged into a slightly curved process terminating in a fine point, are attached to its inferior surface*

This remarkable *Dysdera* was taken in Pernambuco by Mr. Eyton Williams, from whom I had previously received an immature female of the same species.

XLV.—*Further Observations on the Structure of* Foraminifera, *and on the larger Fossilized Forms of Scinde, &c., including a new Genus and Species.* By H. J. Carter, Esq., F.R.S.

Further Observations on the larger Fossilized Forms of Foraminifera in Scinde, &c.

[Continued from p. 382.]

Orbitoides, D'Orbigny.

"*Lycophris dispansus,* Sow." (Ann. Nat. Hist. *l.c.* p. 172), better named by D'Archiac and Haime (p. 349) "*Orbitoides dispansa.*"

Largest size.—Breadth about 1 inch; thickness $\frac{3}{12}$. This specimen is ephippial.

Loc. Lukput, in Cutch. Many parts of Scinde. Valley of

* For a description of an immature female of this species, see Ann. and Mag. Nat. Hist. ser. 3. vol. ii. p. 334.

Kelat (Dr. Cook). Not in Arabia, so far as my observation extends, although I have no doubt it exists there; but I mention expressly that I have not seen it in Arabia, to correct an error which I have made in my Memoir on the Geology of the South-east Coast of that country (Geol. Papers, Western India, p. 592 *et seq.*), in stating that the limestone at the village of Takah, on this coast, which is charged with *Orbitolites Mantelli*, contained also "*Orbitoides Prattii* and *O. dispansa*," which latter I have since found out to be *Heterostegina*, whose quadrangular chambers, while the fossils were yet in the matrix, led me to assume that they were *Orbitoides*, and thus to make the mistake.

Associates.—*N. exponens* and *N. biaritzensis* at Lukput, in Cutch; *N. Ramondi* at Wasna, in Rajpipla; *N. exponens*, *Assilina obesa*, *N. perforata*, *Alveolina elliptica*, and *Conulites Cooki* in the valley of Kelat (Dr. Cook); the deposit of diminutive Foraminifera, viz. *Operculina*, *N. kelatensis*, *Alveolina elliptica*, *A. meandrina*, and *Orbitolina*, also in the valley of Kelat (Dr. Cook).

Obs.—In my former description of this fossil (Ann. Nat. Hist. p. 173) I went into its structure a little, chiefly to contrast the latter with that of *Orbitolites Mantelli*, Cart. (*Orbitoides Mantelli*, D'Orb.); but having since obtained specimens which elucidate this more fully, on account of the whole of the cavities of the test, which formerly contained animal matter, having become richly infiltrated with red and yellow oxide of iron, while the rest remains perfectly free from it, I will now return to the subject more particularly, in doing which I shall not only be able to show much more strikingly how it differs from *Orbitolites Mantelli*, but also be able to point out the position occupied by the sarcode during the lifetime of the animal, almost as satisfactorily as if I had it living in the test at the present moment.

Structural description.—In structure, *Orbitoides dispansa* (Pl. XVI. fig. 1, &c.) consists of a *horizontal plane* of oblong chambers (*b* 1), from each side of which proceeds a *vertical growth* of compressed columnar ones (*b* 2).

The *horizontal plane*, which is more or less wavy, is composed of a single layer of oblong quadrangular chambers arranged in concentric rows around the germ-cell (Pl. XVII. fig. 1 *m* 1, *n* 1), which is spherical, and may not exceed much its original size or may become very much larger, but always seems to be a little larger than the chambers of the rows which next follow it in development (fig. 1 *m*, *n*); it is also hardly ever, perhaps never, without a second cell which very nearly embraces it, and this in the section assumes a more or less semilunar shape (*m* 2, *n* 2). To the former, or germ-cell, Dr. Carpenter has (in *Orbitolites*)

applied the term "central," and to the latter, "circumambient cell." When the germ or central cell and its accompanying one remain minute, that is, not more than the 1-630th of an inch in diameter, the chambers immediately around it are equally so, but increase in magnitude with their distance from the centre; on the other hand, when they are large, the immediately surrounding chambers are proportionately large, but gradually diminish to the usual size, after which they also begin to increase slightly again with their distance from the centre, in the normal way. Thus the structure of the centre may be compact or open, but, from the open structure diminishing to a certain degree and then enlarging again, it may be assumed that the former or compact structure, where the chambers undergo an uninterrupted and gradual increase in size from the centre outwards, is the normal form. After a certain distance from the centre, the increase in size appears to cease, on account of the maximum size of the chambers having been attained, when they again begin to decrease in magnitude towards the circumference.

The rows of chambers, whether arising from a minute or large central cell and its accompaniment, have a tendency to a cyclical arrangement from the first, and very soon complete one (Pl. XVII. fig. 1 *m*, *n*); that is, they very nearly surround the central chambers first for a few rows, which tend to keep on one side, and then at last embrace it by completing the circle. Formerly I thought they began multi-spirally, and I gave an illustration of this (Ann. Nat. Hist. ser. 2. vol. xi. pl. 7. fig. 26); but latterly I have found out that this illustration was taken from the centre of a minute *Heterostegina*, as before stated, and that *Orbitoides dispansa* tends to a cyclical arrangement in the centre as much as, if not more than any other discoid Foraminifer. As the rows extend outwards they bifurcate every now and then, and every now and then one seems to stop altogether; so that this causes an increase and decrease in the number of rows respectively; but the latter is of course less than the former, otherwise there would be no extension of the plane at all. This irregularity, therefore, is attended by frequent interruption of the circle, and thus leads to a more or less irregular aspect of the rows generally throughout the plane.

The chambers in the normal form (that is, where they commence from a minute cell) are small and cubical in the centre (Pl. XVI. fig. 1 *h*), but become elongated horizontally and compressed vertically with their distance from it (fig. 1 *g* 1); so that they soon assume a narrow quadrangular form (*k* 1), which is furthermore altered by becoming convex externally and concave towards the centre, in which direction, also, their long axis is at first situated; but as the outermost rows of the full-grown test

are reached, they undergo the change common to the discoid Foraminifera; that is to say, their vertical axis becomes the longest, from the diminution of the horizontal one (*i*). The chambers also vary greatly in length, and this causes a corresponding irregularity in the rows of which they form a part,—thus reducing the row gradually almost to a mere line, and then expanding it out again to its full size (Pl. XVII. fig. 1 *n*); at other times the chamber becomes doubled, and thus the row appears to bifurcate as just stated; while on other occasions, again, the opposite takes place, viz. the chamber ceases to be developed, and the adjoining rows closing in, the abortive row thus terminates or ceases to exist. The additional row or bifurcation probably begins in an offset from one of the annular canals which will be presently mentioned, and should be regarded as a "branch," like the branches of the spire in *Nummulites*. (Reference to the figures in the first row of Pl. XVII. will facilitate the explanation of all this.)

Lastly, the chambers are, for the most part, arranged alternately in adjoining rows, and each communicates by two canals or stolons with the two immediately before and behind it; so that every chamber has four others in connexion with it (*k*, *l*). In this we have an arrangement analogous to the "oblique" canal-system in *Orbitolites Mantelli*, which will be described under this head.

Canal-system.—Here and there my horizontal sections present a distinct canal-system (*k*3, *l*3), consisting of single annular canals situated between the rows of chambers respectively, connected with each other by straight smaller branches which pass through the interseptal spaces; so that each chamber is thus enclosed in a quadrangular mesh of canals, and the whole together form a meshwork plane which is double; that is to say, one exists on each side the horizontal plane of chambers, on a level with the chambers, so as to have the stolon-processes between them. Why the canal-system should only appear here and there in remnants in my sections, I cannot say, unless it be from variation in their size, from imperfect infiltration, or from total absence in parts. Again, from their being analogous to the annular canals of *Orbitolites Mantelli*, which will be described presently, as well as to the great spiral canals of *Operculina* and *Nummulites*, one would expect the proximal ends of the chambers to be united to them: and this is actually the case; that is, the chambers have often a bond of union of this kind when the entirety of the annular canal is not visible, and are as often without it when the annular canal, in its entirety and separation, is present (*k*); while I know of no other structure of the kind in the horizontal plane but this annular canal-system and the stolon-process, except,

perhaps, some delicate canals of union between the chambers through the interseptal spaces, too small, in my specimens, to be satisfactorily seen.

Vertical growth.—This, on the other hand, is composed of columns of compressed chambers of an irregular shape (*d*), which grow out vertically from the layers of the horizontal plane, and beginning from the central cell, increase in number, vertically and horizontally, with the extension of the horizontal plane, which thus causes them to be most numerous in the centre, and so assume a convex form, which is most prominent at this part. Besides this, the difference in degree of vertical compression, in these cavities, leads to the centre in one specimen being abruptly raised and in another almost flat, viz. where they are inflated and compressed respectively; added to which the prominence in the centre may also depend more or less on the size of the central and circumambient cells.

With the layers of compressed chambers a number of opake white columns, consisting merely of condensed shell-substance, are developed (*d* 1), which, arising in points situated on the interseptal spaces of the horizontal plane, gradually increase in thickness vertically, as they radiate also, slightly, from their origins, to terminate on the surface (*b* 2).

The compressed chambers of the vertical structure, as before stated, are very irregular in form (*a* 2, *c* 2), and much larger than the chambers of the central plane, from which they are developed partly through the medium of minute vertical tubes extended through the shell-substance of the test, in the same way as in *Operculina* and *Nummulites* (*d* 3, *g* 4), and partly by stolon-processes passing obliquely upwards through the intercameral spaces (*e* 5, *f* 3, 4). Thus each compressed chamber is seen to be united to those immediately above and around it by several of these processes; and thus these cavities assume a columnar arrangement radiating from the central plane, while part of the interspaces between them is filled up by the opake columns. But the opake columns, as well as the columns of chambers, bifurcate, and thus become multiplied to fill up the intervals which would otherwise be caused by their radiation, whereby also the chambers become diminished in size, and thus, on the surface, appear subordinate in this respect to the peripheral ends of the columns (*a* 1); so that the convex surface of the fossil presents a number of white points, which are the ends of the opake columns of shell-substance, surrounded by polygonal divisions which, on their part, are the ends of the columns of the compressed chambers (*a*), the interspaces between which, again (that is, between the chambers), form the radiating straight stellate lines of connexion between the

columns (*a* 3, *c* 3), across which linear interspaces, lastly, the stolon-processes pass that unite the chambers (*c* 4). The stellate lines, from their transparency, are frequently not seen; but when opake and white, they give the surface and horizontal section a star-like appearance; their apparent absence, therefore, does not constitute a specific difference. I have never seen any of the stolon-processes passing through the opake columns; neither have I ever been able to detect a point of yellow ochre in the peripheral extremities of the columns in the infiltrated specimens, indicative of their having been pierced by a vertical canal, although I have had infiltrated specimens in which this must have been the case, had there been one.

Here it is necessary for me to correct an error in my former communication on this subject (Ann. Nat. Hist. *l. c.* p. 173), where I have stated that the "opake columns" are "columns of cells." In *Orbitolites Mantelli* there are *no* opake columns, as will presently be seen, but there are *columns of compressed chambers,* as in *Orbitoides dispansa*; and the only way in which I can account for my misstatement is, that the resemblances between *Orbitoides dispansa* and *Orbitolites Mantelli,* on superficial examination, are so great that I must have been describing from a specimen of the latter in my hand when I committed this error. The best distinguishing character, indeed, between these two fossils, for field purposes, is the presence of the opake columns in *Orbitoides dispansa* and their absence in *Orbitolites Mantelli.*

Spherules or propagative agents.—As in *Operculina* and *Nummulites,* so in *Orbitoides dispansa,* these bodies are frequently observed throughout the cavities and canals of the test (Pl. XVII. fig. 1 *o*), equally filling the central as well as the peripheral chambers, and equally traversing the vertical tubuli as well as the intercommunicating canals between the chambers; so that in this way they readily find a passage from even the most internal cavities of the organism to the exterior. In their development, judging from the full-grown specimens, the spherules may grow considerably beyond the size which they have at their exit from the parent, or very little exceed it, but are almost, if not always, followed by the development of a much larger chamber, viz. the "circumambient" one, as before stated, previous to the development of the rows of small chambers. They vary in size from 1-2000th of an inch downwards.

Orbitoides asterifera, n. sp. (Pl. XVII. fig. 3).—The only difference between this form and that of *O. dispansa* is that it is much smaller, has an asteroid elevation on the surface consisting of six or eight rays extending from the centre towards the circumference, where they bifurcate; the surface-ends of the

opake columns, too, are separated from each other by many chambers, while in *O. dispansa,* for the most part, they are only separated by a ring of single chambers.

Largest size.—Breadth $\frac{4}{12}$ inch.

Loc. Valley of Kelat (Dr. Cook).

Associates.—From the same bed of diminutive Foraminifera as *N. kelatensis,* under which see its associates.

Obs.—Excepting the asteroid growth of this fossil, there is nothing but the greater number of chambers which intervene between the peripheral end of the columns to make it differ from *O. dispansa.* Plane, expanded, and asteroid forms exist, indiscriminately mixed together in the same deposit, but all diminutive, like the rest of the Foraminifera of which this bed is composed. The rays or ridges are occasioned by the "vertical growth" of the test having been arrested between them.

Note.—On comparing the sectional figures of *O. Prattii* given by Dr. Carpenter (Quart. Journ. Geol. Soc. vol. vi. pl. 8) with *O. dispansa* (*Lycophris dispansus,* Sow.) and *L. ephippium,* I can see no difference whatever between them, and therefore must consider all as *O. dispansa,* while the asteroid form just described hardly differs sufficiently from any to deserve a separate specific appellation. Hence, at present, I know but one type of all these *Orbitoides,* viz. *O. dispansa.*

Orbitolites Mantelli, Cart.

"*Orbitolites Mantelli,* H. J. C." (Ann. Nat. Hist. *l. c.* p. 174).—Is it this fossil that D'Archiac and Haime state, in their "Table" (p. 363), "est bien l'espèce des Etats-Unis," viz. that called *Orbitoides Mantelli* by D'Orbigny? To this question I have already answered "Yes." It corresponds with the figures of this fossil given by Dr. Carpenter (Quart. Journ. Geol. Soc. *l. c.*); and having obtained specimens of it almost as richly infiltrated with yellow oxide of iron as those of *Orbitoides dispansa,* I will now also describe its structure much more minutely than I have before done, as much for the purpose of still further contrasting the differences between these two fossils as for recording the minute anatomy of the fossilized test itself, which the infiltration enables me to do almost as well as that of *Orbitoides dispansa.*

The test of *Orbitolites Mantelli* (Pl. XVI. fig. 2, &c.) consists of a *horizontal plane* of globular and cylindrical chambers (*b* 1), from each side of which proceeds a *vertical growth* of columnar ones (*b* 2).

In the *horizontal plane,* everything is the same—in respect of waviness, mode of growth around a minute or large central cell (Pl. XVII. fig. 2, *n* 1) and its circumambient chamber (*n* 2), the relative size of the chambers, their arrangement in rows, the bi-

furcation and effetation of the rows, and their consequent multiplication and disappearance, the incomplete and lateral growth at first, their subsequent entire concentricity, and the plane being only one chamber deep—as in *Orbitoides dispansa.* But the chambers are quite different in shape from those of *O. dispansa,* different in the direction of their increase in size and in the arrangement of the canal-system or sarcodal bands which accompany them. They also frequently present an arrangement like that of the interspaces and lines on an engine-turned watch-case, at the commencement (*m*); and although I believe they become as much concentric as the rows in *Orbitoides dispansa,* still, out of many successful sections in other respects, I have never been able to trace a row completely round, that is, forming an entire circle; it has always bifurcated or thrown off another row, or become diminished to the annular canal, which could be traced on for some distance and then disappeared, or began again to bear chambers which could not well be identified with those of the original row (*n*).

The chambers in the normal form, that is, where they commence from a minute cell, are small and globular in the centre (*h*), but become larger and elongated *vertically* with their distance from it (*h'*); so that they soon assume a cylindrical form, which presents a curve towards the centre and a corresponding convexity in the opposite direction: thus the plane becomes much thicker towards the circumference, indeed is thickest there (*g* 1), although, as in all other instances, the horizontal diameter of the chambers is diminished (*i*). The chambers are also arranged alternately in adjoining rows, and united together by systems of *oblique* and *annular* canals, which were originally filled with sarcode, and to which we will now particularly direct our attention.

The *oblique system* (*l* 4) consists of canals or bands which pursue an oblique course from the centre to the circumference, like the lines on an engine-turned watch-case, that is, making each a semi-gyration from the centre to the circumference; and as there are two (?) sets of these canals at the commencement, situated respectively in two distinct and separate planes, and the canals of each plane gyrate in opposite directions respectively, so their interstices are quadrangular, and have their angles circularly and radiatingly opposite to each other, also like the interstices of the figure on the watch-case; while in the inner angle of each of the spaces is placed the chamber, in contact with the two canals, as they cross each other on different planes at this point (*k*, *l*). At first there are only two planes of these canals or bands, but as the chambers become elongated vertically they may be increased to four and six (*g* 4). The largest infil-

trated specimen of *Orbitolites Mantelli* in my possession presents six at the circumference, all of which communicate in the way mentioned with the outer rows of chambers (*g*).

The *annular system* (*k* 3, *l* 3), on the other hand, consists of two planes only of canals, arranged in concentric circles, which are situated respectively on either side of the horizontal plane, on a level with the end of the chambers, with which they are in contact on the inner side, one to each row (*g* 4). Why these canals should not be scolloped or wavy in the infiltrated specimens, as they are in the uninfiltrated ones and in *Orbitolites* (Pl. XVII. fig. 2 *o*), I cannot say.

In connexion with these, again, there are other indistinct sets of more delicate canals, one of which unites the annular bands transversely, that is, passing between the chambers (*l* 4), another unites them vertically (*g* 6), and a third set, which is only seen here and there, proceeds vertically outward between the cells of the *vertical growth*, where it appears to be lost. The first set corresponds with the transverse branches between the annular canals in *Orbitoides dispansa* and to those which, in *Orbitolites*, appear to give origin to the chambers of the following row.

Vertical growth.—This, again, in its mode of increase, convexity of the layers of which it is composed (Pl. XVI. fig. 2 *b* 2), consequent compression and columnar arrangement of the chambers (*d*), their being larger than the chambers of the horizontal plane with which they are in contact and from which they are developed, the occasional bifurcation of the columns, and the successive development of the compressed cavities of which they are composed being due to minute vertical tubular communications which pass through the shell-substance exactly like those observed in *Operculina* and *Nummulites* (*d* 1), together with the lateral stolon-processes traversing obliquely outwards the intercellular spaces (*d* 3),—all exactly resemble the same parts in *Orbitoides dispansa*. But there is a total absence of the opake columnar structure; and the columns of compressed cavities, not having this obstruction to their lateral development, are wider at their peripheral ends, while the intercameral spaces are consequently smaller than the same parts in *Orbitoides dispansa* (see sections *c*, *d*). The peripheral ends of the chamber-columns are also more or less circular, and in the little angular spaces between them may be seen the ends of one or more of the *ascending* intercommunicating canals which connect the columnar chambers vertically, and thus complete the line of transit between the centre and surface, besides affording stolons, perhaps, for the formation of new chambers (*c* 3, *e* 4, *f* 4).

Hence there is a great difference between this fossil and *Orbitoides dispansa*, while no one can help seeing that it is most

closely allied to *Orbitolites* in the structure of its horizontal plane (see Dr. Carpenter's sections of *Orbitolites* in Phil. Trans. *l. c.*) any more than one can help seeing that *Orbitoides dispansa,* in the structure of its central plane, is most closely allied to *Cycloclypeus,* Carp.

Alike, therefore, as *Orbitoides dispansa* and *Orbitolites Mantelli* may be in other respects, they are, in the structure of the central or horizontal plane, as strikingly different as *Orbitolites* and *Cycloclypeus.*

For field-service, the absence of the white columns and increasing thickness of the horizontal plane towards the circumference, as above stated, at once distinguish *Orbitolites Mantelli* from *Orbitoides dispansa.*

Dr. Carpenter (Phil. Trans. 1856, p. 195, foot-note) states that I have fallen into an error, which has been corrected by D'Archiac and Haime (p. 349), in placing what M. d'Archiac considered before as "*Orbitolites*" under the head of *Orbitoides dispansa* and *Orbitoides Fortisi* seu *Prattii,* with reference, I suppose, to my having changed the name of the fossil first described from "*Orbitoides Mantelli*" to "*Orbitolites Mantelli.*"

I have, however, just stated that *Orbitoides dispansa* and *Orbitoides Fortisi* seu *Prattii* are the same, and have *always* done so. That *Orbitoides Mantelli,* D'Orb., is very different, I have also shown; but I question, now that Dr. Carpenter has so clearly defined *Orbitolites,* whether *Orbitoides Mantelli* ought to retain the name under which I have described it, any more than *Orbitoides dispansa* should be called "*Cycloclypeus dispansus.*" I think it had better even have retained the old name of *Orbitoides Mantelli,* D'Orb. But it must be plain now, that if *Orbitoides dispansa* is to be considered the type of the genus, our *Orbitoides Mantelli,* D'Orb., is not of this type, and therefore should still have another name. It has already had three, viz. 1. *Nummulites Mantelli,* D'Orb.; 2, *Orbitoides Mantelli,* D'Orb.; and 3, *Orbitolites Mantelli,* Cart.

Propagative spherules.—I have observed these bodies in some of the cells of the infiltrated specimens of *Orbitolites Mantelli,* but they are not numerous; and it is only here and there that I have been able to observe them in the specimens of *Nummulites sublævigata,* with which they are imbedded; while the imperfect infiltration of the whole, compared with the specimens of *Orbitoides dispansa,* &c., from Wasna, in which these "spherules" abound, seems to indicate that the former were imbedded long after death, while the latter must have been imbedded almost alive.

"2. *Orbitolites* ——?" (Ann. Nat. Hist. *l. c.* p. 175, pl. vii. figs. 40, 41).—The specimen thus noted and alluded to by D'Arch.

and Haime (p. 350) as being perhaps *Orbitoides Fortisi* is the fossil from which I have made out the structure above given, the only difference between it and *Orbitolites Mantelli* being that the columns of cells terminate at the convex part or periphery in polygonal instead of circular cells,—a difference which is hardly enough to make it more than a variety, as the cells are anything but circular in the assumed typical form.

Associates of Orbitolites Mantelli.—*Heterostegina* and *Cycloclypeus*, in white limestone at the village of Takah, on the south-east coast of Arabia; *Nummulites sublævigata*, in yellow argillaceous limestone, in Scinde. (This is the specimen to which I have just alluded as being but a variety of *Orbitolites Mantelli*, and from which the structural description above given was taken. It is imbedded with the richly infiltrated mass of Nummulites, from which the diagram of Nummulitic structure given in the plate accompanying my description of the structure of *Operculina arabica* was compiled.)

Obs.—I have never found *Orbitolites Mantelli* with any other Nummulite than *N. sublævigata*, and this only in the specimen above mentioned from Scinde, although it is very common in Scinde.

Like *Orbitoides dispansa*, it is sometimes small and prominent in the centre, at others more or less flat, twisted, and expanded, like the ephippial varieties of *O. dispansa*. The latter, from the wavy and fragmentary state in which it occurs in the matrix, led me into the conjectural error of stating that it sometimes seems to spread itself out in a thalloid form, like the Polyzoa, whereas subsequent examination tends to the conclusion that it always assumes a discoid form, although much more expanded and thinner in some instances than in others*.

* Since the above was written I have had the opportunity of further confirming the opinion I have given, that the expanded forms of *Orbitolites Mantelli*, Cart., are never indefinitely thalloid like the polypidom of the Polyzoa, but always discoid, in a mass of these fossils sent to me by Dr. Cook, which he obtained from a small series of limestone strata overlying serpentine and diorite rock close to the village of Nal, in Beloochistan, about eighty miles S.S.W. of Kelat.

This mass, which is a specimen of the stratum from which it was taken, is so foliated in structure, that it looks like a deposit of leaves; but when examined, it is found to consist of nothing but *Orbitolites Mantelli*, *Heterostegina*, *Cycloclypeus*, and *Orbiculina*, all together and lying parallelly upon each other, in a softish yellow marl.

The largest specimen of *O. Mantelli* forwarded to me is $2\frac{1}{2}$ inches in diameter, $\frac{1}{6}$ inch thick in the centre, and the central prominence or vertical development not more than $\frac{1}{3}$ inch wide; while the horizontal portion, extending 1 inch beyond this all round, is not more than $\frac{1}{16}$ inch thick halfway between the margin and the centre, and increases but a very little more even up to the vertical development. It is this small vertical and great horizontal development, which led me formerly, when I had

If, as I have before inferred from its being confined to the lowest deposits of the Nummulitic Series, *N. sublævigata* be the oldest form of Nummulites, then this may be the locality and age of *Orbitolites Mantelli*; but if, as subsequently stated, this be a Middle Tertiary Series, then *O. Mantelli* and *N. sublævigata* would belong to the youngest or latest-formed species of larger Foraminifera,—which I now think most likely, as the bed of *Orbitolites Mantelli*, *Heterostegina*, and *Cycloclypeus*, together with that containing the reticulated Nummulite *N. masiraensis*, in the island of Masira, on the south-east coast of Arabia, and that containing *N. sublævigata*, at Muskat, would then all be in the littoral division of the Nummulitic series of this part of the coast of Arabia, the other or lower division forming the summits of the great scarps a little more inland.

Conulites, nov. gen.

Conulites Cooki, n. sp. (Pl. XV. fig. 7, &c.).—Conical, discoidal, more or less depressed, consisting of a cortical layer of rhomboidal chambers (*d*) filled with a columnar structure which slightly projects in a convex form beyond the base (*c*, *e*). Cortical layer composed of a spire of chambers commencing from the apex and terminating at the circumference of the base (*d*); septal lines of the chambers oblique; chambers rounded internally (*l* 2, *g* 1). Columnar structure radiated (*c*, *e*), consisting of convex layers of compressed chambers, which are more or less arranged in columns, united by stolon-processes, and interspersed with opake white columns (*f*). Opake columns conical, growing from points on the inner aspects of the chambers and terminating in dilated extremities at the base, which thus acquires, when weather-worn, a granular surface (*b*, *e*). Apex surrounded externally by a thin columnar growth of shell-substance, which extends about halfway up the side of the cone, and there gradually subsides into small granular projections situated on the points of contact between the septa and the spire (*e* 1).

only a fragment or two of this variety without the centre, to infer that the fossil sometimes had a thalloid growth, like the polypidom of the Polyzoa.

The *Heterostegina* is very small, and the *Cycloclypeus* and *Orbiculina* under half an inch in diameter, so far as I have seen; but probably there are much larger specimens of all these fossils in the deposit.

In a geological point of view, it is interesting to find *Orbitolites Mantelli*, *Heterostegina*, and *Cycloclypeus* occurring together in a bed overlying serpentine and diorite rocks in the locality above mentioned, since they are found together in a bed in the middle of the south-east coast of Arabia, where the Nummulitic series also reposes conformably on rocks composed of diorite and serpentine.—Bombay, Oct. 12, 1861.

Largest size.—Breadth at base $\frac{5}{12}$ inch; height of cone $\frac{2\frac{1}{2}}{12}$ inch.

Loc. Seinde, locality unknown. Valley of Kelat (Dr. Cook).

Associates.—*N. exponens* (var. *b*), *Assilina obesa*, *N. perforata*, *N. biaritzensis*, *N. spira*, *Alveolina elliptica*, and *Orbitoides dispansa* in the Valley of Kelat; *N. Carteri* and *N. spira* in Scinde.

Obs.—I first recognized this fossil amongst some Nummulites sent from Kelat by Dr. Cook, and then in the mass in some specimens from Scinde previously in my possession. The spire is generally single throughout, but sometimes bifurcated so as to become double; and the same with the septal lines, which have a radiating spiral tendency from the apex towards the circumference; while the columnar structure, in respect of the chambers and columns, is almost identical with that of *Orbitoides dispansa*. As yet, I have met with no specimens sufficiently infiltrated with yellow oxide of iron to enable me to follow out the internal structure minutely. This fossil is very like the conical forms of *Orbitolina*, but differs in the cortical layer consisting of a *spire* instead of *concentric rings* of chambers, and in the columnar structure being accompanied by the white opake columns. Thus *Conulites* belongs to the "Hélicostègues" of D'Orbigny.

Orbitolina, D'Orb.

1. *Orbitolina lenticularis*, Lamk. (Pl. XVII. fig. 5, &c.).—Conical, obtuse, slightly excavated or patulous; margin everted, external surface presenting concentric rings; patulous surface presenting granulations, which are more or less confused in the centre, but arranged in radiating lines towards the circumference.

Size.—Breadth $\frac{2}{12}$ inch; height $\frac{1}{20}$ inch.

Variety *a*. Conical, acute, deeply excavated.

Size.—Breadth $\frac{1}{8}$ inch; height $\frac{1}{20}$ inch.

Variety *b*. Flat, circular, wavy, thick; thinning towards the circumference.

Size.—Breadth $\frac{2}{12}$ inch; height $\frac{1}{32}$ inch.

Variety *c* (fig. 6). Discoidal, almost flat, very thin, papyraceous.

Size.—Breadth $\frac{8}{12}$ inch; thickness $\frac{1}{48}$ inch.

Loc. All from the south-east coast of Arabia, at Ras Fartak, with fossils of the Cretaceous age.

Obs.—These Foraminifera I first described under the name of "*Orbitolites*" in my "Memoir on the Geology of the South-east Coast of Arabia" (Journ. Bombay Asiat. Soc. vol. iv. p. 71), and then again under that of "*Orbitolina patula*" (Geol. Papers Western India, pp. 549 & 603), since which I find that the

species, when compared with Pictet's figure (Traité de Paléontologie, pl. 109. fig. 7), is distinctly that of the "perte du Rhône," viz. *Orbitolina lenticularis*, Lam., under which name it is now given; and I cannot help thinking, with Messrs. Parker and Jones (Ann. Nat. Hist. ser. 3. vol. vi. p. 36), that D'Orbigny's *Cyclolina* must be intended for the flat and expanded variety (*c*) of this fossil. Perhaps, also, his figures of it were taken, by mistake, from *Orbitolites*; but of this more hereafter.

These fossils abound to such an extent at the place mentioned, that a bed of stratified blue limestone upwards of 100 feet in thickness is almost entirely composed of them; while the presence of Ammonites and Cretacean fossils in the superincumbent strata, also more or less richly charged with *Orbitolina*, proves the whole to be of Cretacean age.

Structure of Orbitolina lenticularis.—This fossil, like *Conulites Cooki*, is composed of a cortical layer of chambers externally (*g* 2), which is more or less conical in shape, and more or less filled internally with a columnar chamber-structure (*g* 3). The cortical layer here, however, is composed of concentric rings of chambers, which begin in a central cell at the apex (*d* 4) and terminate at the circumference of the base. Each annulus is divided into a number of chambers with straight septa (*d a*), faced superficially by a reticular subseptal structure (*d* 1), which extends into the chambers a certain distance, but not throughout; so that when this facing or superficial reticulation is removed by acid, the larger divisions beneath come into view (*d* 2).

The columnar structure, again, as in *Conulites*, is composed of layers of compressed cells which more or less fill the cone, according to the species (*g* 3), and sometimes extend even beyond the base so as to give this a convex surface. But there are no opake-white columns here, as in *Conulites*, and the granulations on the patulous surface and convexity of the base respectively (*e*) represent the ends of the columns of cells as in *Orbitolites Mantelli*. While, therefore, *Conulites* is most like *Orbitoides dispansa*, *Orbitolina* more resembles *Orbitolites Mantelli*; but *Conulites* still differs from both in the great chamber-layer being helical, instead of cyclical, as before stated.

2. *Orbitolina* —— ? (Pl. XVII. fig. 7, &c.).—Conical; base convex; annular spaces wider and more reticulated than in the foregoing species. Internal structure the same as that of *O. lenticularis*.

Largest size.—Height $\frac{21}{12}$ inch; breadth at base, a little more.

Loc. Valley of Kelat (Dr. Cook).

Associates.—*Alveolina elliptica*, in white limestone; the diminutive Foraminifera in the bed before mentioned, valley of Kelat (Dr. Cook).

3. *Orbitolina* —— ? (fig. 8, &c.).—The same as the foregoing, but with no reticulation on the surface, and the septa indistinctly developed.

Largest size.—Height $\frac{7}{48}$ inch; breadth at the base about the same.

Loc. Buran River, in Scinde, in limestone charged with *Orbitolites pedunculata*, Cart.

Associate.—Orbitolites pedunculata.

4. *Orbitolina* —— ? (fig. 9, &c.).—Of the same shape as the last, but the cortical layer consisting of long chambers twisting round the cone, and interdigitating with each other at their commencement and termination.

Largest size.—Height $\frac{6}{48}$ inch.

Loc. South-east coast of Arabia, close to Ras Sajar, in white limestone richly charged with *Orbitolites.*

Associate.—Orbitolites.

Heterostegina, D'Orb.

Heterostegina pleurocentralis, n. sp. (?).—Elliptical, thin, flat, wavy. Surfaces presenting a corresponding prominence on each side, situated laterally and towards one end of the ellipse; covered with minute tubercles, which, becoming larger eccentrically, pass off into moniliform rows that, after a subspiral course, terminate on the margin. Internally consisting, except at the prominence, of a single plane of oblong chambers filling up the intervals between the rows of tubercles, with their long axes horizontal and across their subspiral course. Margin inflated, round, smooth.

Largest size.—Longest diameter $\frac{3}{8}$ inch.

Loc. Village of Takah, on the south-east coast of Arabia, in white limestone.

Associates.—Cycloclypeus and *Orbitolites Mantelli.*

Obs.—This and *Orbitolites Mantelli* are very numerous together in the white limestone at the place mentioned. Although smaller, it differs so little from the species found at Malta, that I think they should be regarded as the same.

Note.—Misled by the figure of Lamarck's *Orbiculina adunca* (Encyclop. Méthod. tab. 468), I called this fossil "*Orbiculina pleurocentralis*" (Geol. Papers on West India); but on receiving Dr. Carpenter's kind present of a copy of his second valuable Memoir on the Foraminifera (Phil. Trans. 1856, p. 547), I saw my mistake, and made the necessary correction (Journ. Bombay Asiat. Soc. vol. v. p. 634).

I have designated this Foraminifer "*pleurocentralis*" here, because I had given this name to it formerly; but having since obtained some of the fossil *Heterosteginæ* from Malta, I find the

resemblance between the two so close, that I hardly think that it should be considered otherwise than as a variety of the latter. It scarcely differs more (that is, in the specimens in my possession) than in being a little smaller than the *Heterostegina* of Malta.

The resemblance of the horizontal face of this fossil to *Orbitoides dispansa* seu *Prattii* while in the matrix, led me to think that it was that Foraminifer—an error in both editions of my Memoir on the Geology of the south-east coast of Arabia (*loc. cit.*) which I thus take the opportunity of correcting. As before stated, I did not meet with *Orbitoides dispansa* in Arabia, nor have I ever found *Orbitoides dispansa* together with *Orbitolites Mantelli*; and as I have also before stated, it was the mistaking of the small specimens of this *Heterostegina* among those of *Orbitolites Mantelli* for *Orbitoides dispansa* which led to my giving a section of *Heterostegina* as illustrative of the "multispiral" commencement of the chambers in the latter.

Cycloclypeus, Carp.

Cycloclypeus mammillatus, n. sp.—Circular, thin, presenting a prominence in the centre surmounted by a large tubercle, which is again surrounded by a number of minute ones, the latter passing off in broken lines to terminate in a radiating spiral manner upon the margin. Margin thin, not inflated. Chambers circular in the centre, becoming oblong and quadrangular towards the circumference, arranged in rows, with their long axis in the direction of the horizontal or long radius of the fossil.

Largest size.—I could only obtain one specimen entire, which was $\frac{2}{12}$ inch in diameter.

Loc. Takah, on the south-east coast of Arabia, in white limestone, with *Orbitolites Mantelli* and *Heterostegina*.

Obs.—Here the minute granulations, instead of being on the lines separating the rows, are over the septal divisions between the chambers themselves. Thinking, from my limited means of examination, and from its being associated with *Heterostegina*, that this fossil must be considered one of the same genus, I gave it the above specific designation; but having lately cut away a little of its surface, to examine its internal structure, I find that it is distinctly a *Cycloclypeus*.

The cells of this specimen diminish in size towards the centre and become almost globular; but this may be because the central cell happened to be minute instead of large. In Dr. Carpenter's typical form, however, the cells are deeper in the centre and become shallower outwards; and if this be always the case, then *C. mammillatus* follows what I have considered to be the normal form of the horizontal planes in *Orbitoides dispansa* and

O. Mantelli, especially when commencing with a minute cell, rather than typical *Cycloclypeus,* which, contrary to all the other Foraminifera, appears to *begin* in the centre with large chambers, which go on decreasing in size outwards, without first going down to the smaller size of their situation and then increasing again towards the circumference. But for this, and the chambers exchanging their quadrangular for a globular form towards the centre, together with the smallness of the fossil, there is no difference that I can see between the fossil *Cycloclypeus* of the south-east coast of Arabia and the recent one described by Dr. Carpenter (Phil. Trans. *l. c.* pl. 30. fig. 1).

Orbiculina, D'Orb.

Orbiculina malabarica, Cart.—This fossil, which I had described under the name of "*Orbitolites malabarica*" (Ann. Nat. Hist. ser. 2. vol. xi. p. 425), I found afterwards to be an *Orbiculina,* from its resemblance to *Orbiculina angulata,* Lamk. (Encycl. Méthod. t. iii. pl. 468. fig. 3), and I therefore made this correction in the fifth volume of the 'Journal of the Bombay Asiatic Society,' p. 634, immediately after which (that is to say, before the sheet in which my correction occurred had passed through the press), I had the pleasure to receive, through Dr. Carpenter's kindness, his second 'Memoir' on the Foraminifera, in which I found that he had also made the same correction. I mention this chiefly to point out the great resemblance between the figure in the 'Encyclop. Méthod.' to which I have alluded and *Orbiculina malabarica.* For a description and illustration of the fossil itself, see Ann. Nat. Hist. *loc. cit.*

Variety *a.*

Largest size.—Breadth $\frac{8}{12}$ inch.

Loc. Khattyawar, on the coast near Poorbunder, in yellow compact limestone (Capt. Constable, H.M.I.N.).

Associates.—Fossils of the Middle Tertiary epoch, like those accompanying *O. malabarica* (typical form).

Obs.—The only differences between this fossil and the typical form are that the chambers are much smaller in the specimens from Khattyawar; the structure appears to be finer, and from being in a purer, more compact, and fawn-coloured limestone, which is densely charged with them, they appear, from their light colour and fine structure, to be identical with *Orbitolites complanata*; but the distinct spiral arrangement in the centre, which is very evident under even a strong magnifying lens, establishes the difference directly.

Orbitolites, Lamk.

Cyclolina pedunculata, Cart. (Ann. Nat. Hist. *l. c.* p. 176).—

Since I have had the advantage of Dr. Carpenter's clear and valuable exposition of the structure of *Orbitolites* (Phil. Trans. 1855), there is no longer any doubt of my false identification of this fossil with D'Orbigny's *Cyclolina*, nor of the true one being with *Orbitolites*; and therefore, if it be really a new species, which I also doubt very much, it might now go by the name of "*Orbitolites pedunculata.*" I expect, after all, it will be found to differ very little from *Orbitolites complanata* of the "Paris Basin."

Associates.—*Alveolina elliptica* and a small Nummulite belonging to the *Striatæ*, on the Buran River, in Lower Scinde, and, on the same river, the *Orbitolina* before mentioned, "No. 3;" *Alveolina sphæroidea* and *Operculina* in the white limestone forming the summits of the great cliff-scarps behind Morebat; and also *Orbitolina* "No. 4" *ante*, in broken masses under the great promontory of Ras Sajar, on the south-east coast of Arabia.

Internal structure of Orbitolites pedunculata.—This is the same as that given by Dr. Carpenter in his vertical sections 8 and 9, pl. 6, and in his horizontal surface-view, fig. 8. pl. 7. The chambers in the centre have not run into each other vertically, as shown in Dr. Carpenter's "ideal representation," fig. 6. pl. 5, neither are the chambers of the surface oblong, but globular, while in the centre the rows are frequently oval instead of circular. Both these differences, however, as Dr. Carpenter observes, are no more than marks of variety.

The peduncle at the base in the centre is composed of amorphous shell-substance, through which a number of branched transparent lines extend upwards into the centre of the disk, indicative of their once having been canals, perhaps occupied by sarcode. Dr. Carpenter observes that the fossil was probably attached during its lifetime to some marine body, and therefore the peduncle here may be of very little specific value,—thus reducing the species to *Orbitolites complanata.*

"*Cyclolina arabica,* Cart." (Geol. Papers on W. India, p. 550). —This, if it be a new species, should have its name changed to "*Orbitolites arabica.*" The only difference between it and the Scinde Orbitolite is its larger size and finer structure, which are by themselves worth nothing as specific distinctions: hence, perhaps, this also had better be considered as a variety of *O. complanata.*

Associates.—They have been given above under *C. pedunculata.*

Note.—Feeling satisfied now that these fossils are *Orbitolites*, and not *Cyclolina*, D'Orb., and that I have not found "*Orbitolites*" in the Cretacean strata of the south-east coast of Arabia, I had first to correct my errors in nomenclature to accord with

this conclusion, which has been done above, and next my inferences, which were based on the assumption that this *Orbitolites* was identical with D'Orbigny's *Cyclolina*.

My inference (Geol. Papers, &c., p. 627) that the white limestone forming the summit of the great cliff-scarps on the south-east coast of Arabia was of Cretacean age, because it contained a discoid fossil identical in appearance with *Cyclolina cretacea*, D'Orb. (this fossil, according to D'Orbigny, being confined to the Cretacean period), is perceived to be wrong, since it is now proved to be *Orbitolites*, which brings back the summit-portion of these scarps to Eocene age, as assumed in the first edition of my Memoir on the Geology of this coast (Journ. Bombay Asiatic Soc. vol. iv. p. 95), wherein the fossil itself was also first called "*Orbitolites*."

Again, at p. 701, foot-note, the mistaking of this *Orbitolites* for *Cyclolina* has led to a similar error; for, finding the Scinde Orbitolite associated with fossils of the Eocene period in that country, and considering it also a *Cyclolina*, I inferred that D'Orbigny himself was wrong in restricting the existence of this fossil to the Cretacean period; whereas, now that it is known to be an Orbitolite, the inference is in the opposite direction, and in support of D'Orbigny's assertion.

What, then, is D'Orbigny's *Cyclolina*?—a question which may be first met by stating that "had D'Orbigny made plain what *Cyclolina* is, there would have been no occasion for such a question."

From what Dr. Carpenter has stated, it is evident that he was inclined to view *Cyclolina* as a species of *Orbitolites* (first Mem. p. 226, pl. 7. fig. 14), while Messrs. Parker and Jones (Ann. Nat. Hist. 1860, vol. vi. p. 36) consider it an "excessively outspread" form of *Orbitolina*, "judging from D'Orbigny's description and figures" in his 'Foram. Foss. de Vien.' p. 139, pl. 21. figs. 22–25.

In the latter view I acquiesce now, and even applied the name of "*Cyclolina*" to one of those outspread forms of *Orbitolina* (var. *c*. Pl. XVII. fig. 6) which I found in the great deposit of *Orbitolinæ* on the south-east coast of Arabia (Geol. Papers, &c. p. 549), from its resemblance to D'Orbigny's figures, but wrongly identified it with the "discoid fossil" of the scarp 2000 feet above, now seen to be *Orbitolites*,—the former in company with Cretacean, and the latter among a type of Eocene fossils.

All this confusion has arisen from the imperfect way in which D'Orbigny has described and figured his *Cyclolina cretacea*. It would have been better if he had never written anything about it, than just enough to mislead.

He states that it is "equilateral:" this is a character of *Or-*

bitolites, and not of *Orbitolina*: that the chambers are concentric, "making each a complete circle round the others of the same form;" by which I understand him to mean an *annular* chamber without septa,—in fact, a hollow ring. But, so far as my observation goes, the concentric ring-spaces of *Orbitolina*, if not divided into chambers like those of *O. lenticularis*, should interdigitate with each other as in *Patellina corrugata* (Ray Soc. Pub., Monograph by Prof. Williamson, p. 46, pl. 3. figs. 86–89). This annular form, however, according to D'Orbigny, is the peculiar characteristic of his *Cyclolina*, viz. "circular chambers."

Again, as regards D'Orbigny's figures (*loc. cit.*), nothing can be more like the expanded flattened disk of *Orbitolina lenticularis* than his horizontal view of *Cyclolina* (fig. 22). It has also, according to the shading, an elevated centre, which, however, does not appear in the lateral view (fig. 23). Again, if it were like *Orbitolina lenticularis*, the margin should be rounded and thin, for that of the latter fossil is thin and everted; instead of which it is flat and, if anything, thickened, for it obscures the rest of the fossil when viewed edgewise—if D'Orbigny's figure 23 be correct. If equilateral, it should have the same annular markings on *each* side (see my figures, var. 6, &c. *l. c.*). How, then, can it be an "excessively outspread" form of *Orbitolina annularis*, as assumed by Messrs. Parker and Jones? It is needless to conjecture further; for until the fossil is better illustrated and more satisfactorily described, we shall never know what it is. The peculiarity of "annular chambers," and the discrepancy in D'Orbigny's figs. 22 & 23, where the former represents an elevated centre, and the latter does not show it edgewise, while there is nothing in the short meagre description accompanying it to show that the disk was excavated, render the record almost worse than useless, and show that when anything is to be described it should be done satisfactorily, or a statement made to the effect that the data were not sufficient for the purpose.

EXPLANATION OF THE PLATES.

Plate XV.

Fig. 1. *Assilina exponens*, D'Orb. (*Nummulites exponens*, Sow.), variety *b*: *a*, vertical section; *b*, central portion of spire, nat. size; *c*, specimen of the largest chambers, magnified four times.

Fig. 2. *A. obesa*, n. sp., marginal view: *a*, view of flat surface; *b*, spire; *c*, vertical section, nat. size; *d*, specimen of the largest chambers, magnified.

Fig. 3. *Nummulites broachensis*, Carter: *a*, marginal view, nat. size; *b*, spire and chambers; *d*, flat surface; *e*, specimen of the largest chambers: all magnified.

Fig. 4. *N. makullaensis*, n. sp.: *a*, marginal view, nat. size; *b*, spire and

chambers; *c*, flat surface; *d*, specimen of largest chambers: all magnified.

Fig. 5. *N. Ramondi*, mihi: *a*, marginal view, nat. size; *b*, flat surface; *c*, spire and chambers; *d*, specimen of largest chambers: all magnified.

Fig. 6. *N. kelatensis*, n. sp.: *a*, marginal view, nat. size; *b*, flat surface; *c*, spire and chambers; *d*, specimen of largest chambers: all magnified.

Fig. 7. *Conulites Cooki*, nov. gen. et sp., lateral view: *a*, conical surface; *b*, basal surface; *c*, vertical section, nat. size; *d*, central portion of the spire and chambers magnified, as seen on the surface after the incrustation of the apex has been removed.

e, vertical section of half the fossil, showing—1, incrustation; 2, lateral view of chamber-layer; 3, horizontal layers of chambers; 4, opake white columns of condensed shell-substance, as in *Orbitoides dispansa*.

f, Basal surface, showing—1, ends of the columns of white substance; 2, ends of the columns of chambers; 3, lines of separation between the chambers.

g, Horizontal section, showing—1, part of the spiral chamber-layer; 2, truncated ends of opake white columns; 3, ditto of columns of chambers.

N.B. *d*, *e*, *f*, *g* are all diagrams.

Plate XVI.

Fig. 1. *Orbitoides dispansa*, magnified twice the size of the specimen.

a, Portion of surface, magnified, showing—1, ends of the columns of white condensed shell-substance; 2, ends of columns of chambers; 3, lines of separation between the columns of chambers.

b, Vertical section of entire fossil, the lower part not shaded, showing—1, the horizontal chamber-layer, and, 2, the radiated arrangement of the columns of chambers and opake white columns of condensed shell-substance. This figure has been more or less proportionally magnified for comparison with the corresponding figure (opposite) of *Orbitolites Mantelli*.

c, Portion of surface greatly magnified, showing—1, ends of the opake white columns, in which are seen points representative of still smaller columns, of which the larger ones are composed; 2, ends of the columns of chambers; 3, lines of separation between them; 4, tubular communications between the chambers.

d, Vertical section of part of one of the columns of condensed shell-substance (1) with portions of columns of chambers on each side (2, 2); 3, vertical tubuli of the test uniting the chambers.

e, Horizontal section, still more magnified, showing—1, column of condensed shell-substance; 2, chambers laid open; 3, section through the test, showing the truncated ends of the vertical tubuli; 4, tubes of intercommunication between chambers of the same layer; 5, truncated ends of ditto ascending to the chambers of the next layer, or terminating upon the surface, as the case may be.

f, Vertical section of columns of chambers, to show the tubes of intercommunication between the chambers passing up in a

zigzag form to reach the surface: 1, column of chambers; 2, vertical tubuli of the test; 3, tubes of intercommunication between the columnar chambers; 4, ditto, terminating by open mouths on the surface, thus ultimately enabling all the interior chambers to communicate with the surface.

g, h, i. Vertical sections of different parts of the horizontal plane or chamber-layer, to show the various forms of the chambers at these parts respectively.

g. Portion midway between the centre and circumference, showing—1, chambers of the horizontal plane; 2, tubular communications between them; 3, chambers of the columnar structure; 4, vertical tubuli of the test passing between them; 5, truncated ends of the annular canals; 6, ascending tubes of intercommunication between the chambers of the horizontal and columnar layers.

h. Form of chamber near the centre.

i. Form of chambers in the external rows.

k. Horizontal section of portion of the horizontal chamber-layer, showing—1, chambers; 2, tubes of intercommunication; 3, annular canal above the chamber-layer; 4, ditto below ditto; 5, transverse canals uniting the annular ones.

l. More magnified view of a portion of the same, showing—1, chambers; 2, tubes of intercommunication; 3, annular canals; 4, transverse canals uniting the annular ones.

Fig. 2. *Orbitolites Mantelli*, Cart., magnified twice the size of the specimen.

a. Portion of the surface magnified, showing—1, ends of columns of chambers; 2, shell-substance between them. Observe that there are no columns of condensed shell-substance here.

b. Vertical section of entire fossil, the lower part not shaded, showing—1, the horizontal plane or chamber-layer much thicker at the circumference than in the centre, with, 2, the radiated arrangement of the columns of chambers above, and the *absence* of the opake white columns of condensed shell-substance. This figure has been more or less proportionally magnified, for comparison with the corresponding figure of *Orbitoides dispansa* on the other side.

N.B. Here it should be remembered that the contour of the vertical sections of these fossils respectively only represents that of the specimens from which they are taken, viz. figs. 1 and 2. Either may be compressed almost to flatness, or raised in the thick part to semisphericity. Hence the impossibility of distinguishing them without reference to their minute structure.

c. Portion of surface greatly magnified, showing—1, ends of the columns of chambers; 2, intercameral shell-substance traversed by the tubes of intercommunication between the chambers; 3, truncated ends of some of these tubes ascending to the chambers of the next layer. The latter of course open on the surface when there is no other layer above them, and thus ultimately enable the chambers to communicate with the exterior.

d. Vertical section, showing the absence of the opake white column of condensed shell-substance seen in the opposite figure: 1, columns of chambers; 2, vertical tubuli between them; 3, intervening shell-substance; 4, tubes of intercommunication between the chambers.

e. Horizontal section still more magnified, showing—1, chambers laid open; 2, section through the test, showing the ends of

the vertical tubuli; 3, tubes of intercommunication between the chambers of the same layer; 4, truncated ends of ditto ascending to the chambers of the next layer, or terminating on the surface if there be no other layer above them; 5, intercameral shell-substance.

f. Vertical section of columns of chambers to show the tubes of intercommunication between the chambers passing up in a zigzag form to reach the surface: 1, columns of chambers; 2, vertical tubuli; 3, tubes of intercommunication between the columnar chambers; 4, ditto terminating by open mouths on the surface.

g, h, i. Vertical sections of different parts of the horizontal chamber-layer, to show the various forms of the chambers at these parts respectively.

g. Portion near the circumference, showing—1, chambers of the horizontal layer elongated vertically; 2, chambers of the columnar structure; 3, vertical tubuli of the test uniting them; 4, truncated ends of the annular canals; 5, truncated ends of the oblique canals in union with the chambers of the horizontal layer; each chamber has six uniting with it, viz. three on each side, passing in opposite directions; 6, vertical canals which unite the annular canals above and below the horizontal layer.

h. Form of central chambers; *h'*, ditto, a little further from the centre.

i. Form of chambers of the external rows.

k. Horizontal section of portion of the horizontal chamber-layer, showing—1, chambers; 2, oblique canals of the upper layer; 3, annular canals.

l. More magnified view of a portion of the same, showing—1, chambers; 2, oblique canals; 3, annular canals; 4, transverse canals uniting the annular ones.

N.B. All the figures of this Plate, with the exception of 1 and 2, are diagrams.

Plate XVII.

Fig. 1. *Orbitoides dispansa*: *m*, central portion of horizontal plane or chamber-layer magnified to show the cyclical growth of the rows: 1, central or germ-, and 2, circumambient cells, very small, the latter about 1-630th of an inch in diameter (septal divisions of the chambers omitted; intervals between the dotted lines showing the "rows"); *n*, ditto, ditto, with the central (1) and circumambient (2) cells, very large; the former spherical, the latter almost oblong. Septal divisions of chambers *inserted*.

o. Some of the central chambers of the horizontal plane and columnar chambers charged with propagative spherules. Propagative spherule 1-3000 to 1-2000th of an inch in diameter.

Fig. 2. *Orbitolites Mantelli*: *m*, central portion of the horizontal plane or chamber-layer magnified, to show the cyclical growth of the rows: 1, central or germ-, and, 2, circumambient cells, very large. Chambers omitted; intervals between the dotted lines showing the "rows;" *n*, ditto, ditto, showing the engine-turned arrangement of the rows at the commencement. Central and circumambient cells very small, the largest not more than 1-4000th of an inch in diameter. Chambers *inserted*.

o. Fragment of horizontal chamber-layer, to show how an

additional row (1) commences by a stolon from the preceding annular band. From an uninfiltrated specimen.

N.B. All these figures are more or less magnified, unproportionally.

Fig. 3. *Orbitoides asterifera*, asteroid variety (?) of *O. dispansa*, twice the size of the specimen.

Fig. 4. *Alveolina meandrina*, n. sp., nat. size: *a*, magnified view of surface, showing the tortuous form of the chambers; *b*, longitudinal section through the centre, showing the spiral arrangement of the layers of chambers (the fine lines across the layers represent the vertical canals of the reticulated structure); *c*, transverse section near the centre, showing the spiral manner in which the chambers depart from the longitudinal axis; *d*, transverse section much more magnified, showing the spiral commencement of the layers; *e*, magnified view of a portion of the surface, showing, on one side (1) the reticulated plexus of canals which occupies the external aspect of the chamber, and corresponds to the "marginal plexus" in the "spicular cord" of *Operculina arabica*; 2, portion from which it has been removed, showing the vertical canals between the chambers on which the reticulated portion rested, and thus communicated with the reticulated plexus below (better seen in the next diagram).

f. Diagram to show the canal-structure surrounding the chambers: 1, chambers; 2, marginal plexus or reticulation; 3, vertical canals uniting the marginal plexuses, and corresponding to the "interseptal canals" in *Operculina*.

Fig. 5. *Orbitolina lenticularis*, nat. size: *a*, conoidal surface; *b*, base or patulous surface; *c*, lateral view.

d. Diagram showing—1, arrangement of chambers at the centre or apex, which is at first more or less confused, and then cyclical; 2, external or reticulated chamber-layer; 3, subjacent or large chamber-layer; 4, engine-turned arrangement of chambers below the last-mentioned layer.

e. Magnified view of portion of patulous surface, to show the arrangement of the ends of the columnar chambers in the form of granulations.

f. Horizontal section, showing—1, reticulated layer; 2, large chamber-layer; 3, columnar chamber-structure.

g. Vertical section of half the fossil, showing—1, reticulated layer externally; 2, large chamber-layer; 3, columnar chamber-structure. This section corresponds to fig. 7 *e* of *Conulites Cooki*, but is without the opake white columns of condensed shell-substance, thus bearing the same relation in this respect to *Conulites* that *Orbitolites Mantelli* does to *Orbitoides dispansa*.

Fig. 6. *Orbitolina* ——?, flat variety, nat. size, resembling *Cyclolina cretacea*, D'Orb.: *a*, conoidal surface; *b*, concave surface or base; *d*, vertical section through the centre. The structure is exactly the same as that of *O. lenticularis*.

Fig. 7. *Orbitolina* ——? (No. 2), nat. size: *a*, base; *b*, diagram showing on one side the reticular layer, and on the other the large chamber-layer. The reticulated structure is more dense here, and the large chambers larger, than in *O. lenticularis*.

Fig. 8. *Orbitolina* ——? (No. 3), nat. size: *a*, horizontal section; *b*, portion of surface magnified to show the absence of reticulated structure and imperfectly developed septa of the large chambers.

Fig. 9. *Orbitolina* ——? (No. 4), nat. size: *a*, diagram showing long chambers of surface in upper part, and vertical section through the centre, below.

Fig. 10. *Operculina arabica*: spicule magnified, showing shreds of the interspicular substance (*a*) attached to it.

Fig. 11. The same. Truncated end of the "spicular cord," the arrangement of the great horizontal canals of the "marginal plexus," and the spicules in alternate layers more or less radiating from a central point: *a*, spicular cord; *b*, spiral laminæ; *c*, cavity of chamber; *d*, truncated ends of canals; *e*, truncated ends of spicules; *f*, vertical tubuli of spiral laminæ; *g*, projection of a portion of the spicular cord into the chamber.

Here it will be observed that all the truncated ends of the spicules are not of the same size, which arises from their being so arranged as to interdigitate and overlap each other longitudinally in the general structure, the point of one ending over the middle of another, &c. The projecting portion into the chamber (*g*) only happens where the cord is prolonged inwards to receive the "interseptal canals."

[This diagram, in its prominent features, is drawn from nature, with the minor and unimportant detail supplied from imagination and memory.]

Fig. 12. The same. Portion of the outer part of a chamber (taken from a dried specimen in which the animal was living when it was taken) relieved from its calcareous matter by a very weak solution of nitric acid and alcohol: *a*, lateral portion of chamber made up of small bodies having a hole or depression in the centre, being the remains of the vertical tubuli; *b*, "bodies" more magnified; *c*, septal boundary of chamber in which these bodies are absent, but presenting canals of communication between the cavity of the chamber and the interseptal canals, all now rendered membranous; *d*, interseptal vessel; *e*, chamber laid open, showing small and large reproductive spherules in its cavity, and passing through the canals of intercommunication (*fff*) into the interseptal canal.

Fig. 13. The same. Small reproductive spherule, composed of a globe of glairy substance surrounded by a transparent spherical capsule. 1-5400th of an inch.

Fig. 14. The same. Large reproductive spherule similarly composed, but with the central portion become opake and granular. Size 1-1800th of an inch.

Compare these two figures with the propagative spherules of *Amœba verrucosa*, Ehr., and *Euglypha pleurostoma*, Cart. (figs. 12 & 19, pl. 1. vol. xx. Ann. Nat. Hist. 1857) and of *E. alveoluta* (figs. 32 & 33. pl. 5. vol. xviii.).

Fig. 15. *Nummulites Ramondi*, mihi; vertical section of some of the outer chambers highly magnified to show the presence of the propagative spherules and the two great "spiral canals" of Dr. Carpenter: *a*, spicular cord; *b*, spiral laminæ; *c*, chambers; *d*, continuation of the chamber towards the centre; *e*, spherules; *f f*, truncated ends of the great spiral canals; *g*, interseptal canal sending off two branches to communicate with the great spiral canals respectively.